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Development of Vibration Specifications for LRUs on Fighter Aircraft from Flight Data

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Abstract

Air defense of many countries, notably India use different types of aircraft for their air combat operations. These types could include twin engine or single engine fighters, have twin/single fins and could have radically different design and operational philosophies. On the other hand LRU's and missile/gun platforms may become common as standardization and indeginization and single sourcing is attempted. These could be mounted at various locations of an aircraft fuselage, wing etc. As aircraft age, retrofitting and upgrades are now extremely cost effective. These upgrades especially of radar, avionics etc. need to be accommodated at various locations. Weapon systems also change over time and new advanced technology installed on these aircraft. While these are generally qualified to various standards like MIL-810E, the qualification by these standards is based on a number of assumptions. Sources of vibration identified are engine noise impinging on aircraft structures, turbulence, shock pressure pulse in gun firing, maneuvers, buffeting etc. Typical MIL 810E acknowledges that vibration spectra are characteristic of the particular airframe and evaluated through measured data. It notes that outer regions of flexible structure are especially where the data is required. MIL-810E also provides a zonal test condition at various zones: Wing, fuselage, equipment mounted on engines etc. and accounting for whether the aircraft is propeller driven or by turbine engine, the spectra changes. Typical for helicopter the rotor frequencies drive the zoning that needs to be considered.

The concept of LLPs (Life Limited Parts) is common in the aviation industry. Fatigue issues for the basic airframe is well known and being intensively studies. Howeer, it must be pointed out that detailed development of a qualification spectrum using a maximum response and fatigue damage spectrum can provide lower down times, less expensive overhauls for many fighter squadrons. The data that is thus required includes a preliminary ground vibration test that will identify the structural response characteristics, especially at the outer regions of the flexible structures and correlates this with subsequent flight measurements, identification of zones for in-flight vibration measurement, management of this data for various mission profiles and the subsequent development of a vibration spectrum based on the inventory of aircraft in the country's fighter squadrons. The development of vibration spectrum is based on the use of a methodology proposed by Lalanne [1] damage spectra.

An approach proposed in this work is to carry out a set of limited flight measurements, develop spectra based on maximum response and fatigue damage and compare these with the established specification standards. This paper is intended as a review of present qualification standards and an approach to the development of a qualification spectrum for aircraft presently available in the country's inventory and would be useful for equipment qualification.

Reference

1. Christian Lalanne, "Mechanical Vibration and Shock", Vol. I, 5th Edition, Hermes Penton Ltd., London, 2002.

(Full paper not available)

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